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ABSTRACT

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The Effects of Mathematics Methods Courses on PreService Teachers' Attitudes Toward Mathematics and Mathematics Teaching

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Abstract

Preservice teachers' attitudes toward mathematics not only affect their learning to teach mathematics, but they can also affect their students' performance in mathematics. This pilot project examines the effects of mathematics methods courses on preservice teachers' attitudes toward mathematics. Pre-service teachers seeking elementary licensure take methods courses in mathematics at the K-8 levels. Students were surveyed at the beginning and end of 4 hours of coursework to determine attitudes about mathematics and mathematics teaching. Among other questions, they were asked to rate their attitudes on a scale of 1 to 10, and to describe how their attitudes toward mathematics were formed. Follow-up also included assessing strategies that students used as they taught mathematics during student teaching and their first year of teaching. Data from field experiences revealed that students used strategies related to constructivist teaching. Results indicate that students do change attitudes in the short term; however, long term changes still need to be examined.

Since 1989, when the National Council of Teachers of Mathematics (NCTM) published *Curriculum and Evaluation Standards for School Mathematics*, there has been a call for reform in mathematics education. This document challenged the way that mathematics was being taught by presenting changes which were necessary in mathematics content, instruction, and assessment at the K-12 levels (Reick, 1995). In its document, NCTM stated "the teacher must shift from dispenser of knowledge to facilitator of learning" (Quinn, 1989, p. 236). In 1991 NCTM published *Professional Standards for Teaching Mathematics*. This document "articulates a vision of teaching mathematics and builds on the notion found in *Curriculum and Standards* that good and significant mathematics is a vision for all children, not just a few" (Van de Walle, 2001, p. 4). Four years later, in 1995, NCTM published *Assessment Standards for School Mathematics*, which sounded the need for integrating assessment and instruction and pointed out that assessment plays a vital role in implementing change (Van de Walle, 2001). Other documents, such as the Mathematical and Sciences Education Board *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (National Research Council, 1989) and the Mathematics Association of America *A Call for Change* (1991), have also called for reform in mathematics education. In April 2000 NCTM released *Principles and Standards for School Mathematics*, an updated version of *Curriculum and Evaluation Standards*.

With such a demand for change in mathematics education, it is important to note the ways in which teacher education programs are influencing preservice teachers. This paper examines the effects of mathematics methods courses on preservice teachers' anxiety and attitudes toward mathematics. It also examines the effects that

mathematics methods courses have on preservice teachers' pedagogical beliefs and behaviors.

Literature Review

Anxiety toward Mathematics

Mathematics anxiety, which can be defined as " a lack of comfort that someone might experience when required to perform mathematically, both on tests and in everyday life" (Conrad and Tracy, 1992, p. 4), has been researched more than any other affective domain (Tooke & Lindstrom, 1998). Although this research suggests that the level of mathematics anxiety in preservice teachers may be no greater than that of the general population (Tooke & Lindstrom, 1998), it does suggest that mathematics anxiety is prevalent among preservice elementary teachers (Sloan, Vinson, Haynes, & Gresham, 1997). In 1998 Tooke and Lindstrom wrote the following:

> ...several studies suggest that mathematics anxiety surface most dramatically when the subject either is, or is perceived to be, under evaluation (Wood, 1998). Consequently, elementary teachers responding to students' questions or teaching before supervisors might easily see themselves as being under evaluative conditions, and, thus their mathematics anxiety becomes more pronounced. (p. 1)

Mathematics anxiety can also be linked to poor academic performance in mathematics. In a 1981 study conducted by Wright and Miller, mathematics anxiety was found to be common among people who believed that their mathematical skills were inferior to their abilities in other subjects (Sloan, Vinson, Haynes, and Gresham, 1997).

In 1992 Karen S. Conrad and Dyanne M. Tracy conducted a study in order to investigate the effects of an experienced-based mathematics methods course on preservice teachers' anxiety toward mathematics. The participants included sixty-three elementary education students, fifty-six females and seven males, who were enrolled in a mandatory mathematics methods course. Their ages ranged from 20 years to 41 years, and all of the subjects were Caucasians. At the beginning of the semester, these volunteer subjects were asked to complete the Mathematics Anxiety Rating Scale (MARS). The MARS, developed in 1972 by R.M. Suinn, is a 98 item, self-rating scale that can be administered to groups or to individuals. Every item on the scale depicts a situation which may provoke anxiety within the subject. The subject then decides on the severity of the anxiety by marking (1) for "not at all", (2) for "a little", (3) for "a fair amount", (4) for "much", or 5 for "very much". Raw scores for the MARS can vary from 98 to 490, very low mathematics anxiety to very high mathematics anxiety, respectively (Conrad and Tracy, 1992).

Each week, for a total of fifteen weeks, the subjects met for 3 hours and 20 minutes in an elementary classroom in order to practice the mathematics concepts and teaching methods modeled by their professor. At the conclusion of the fifteen-week period, the subjects were again given the MARS. Conrad and Tracy wrote the following:

> At the end of the 15 weeks many preservice teachers showed significantly lower mathematics anxiety levels as measured by the MARS. There was no significant difference when comparing subjects' age or level of high school mathematics to the lowering of anxiety levels; a course such as this is effective for preservice

> teachers of traditional and non-traditional ages with many different levels of high school mathematics... All preservice elementary teachers are required to take a mathematics methods course. However, the results of this study indicate that an experienced-based mathematics methods course can prepare teachers to teach mathematics with less anxiety. (p. 11-12)

Tina Sloan, Beth Vinson, Jonita Haynes, and Regina Gresham at Athens State College in Athens, Alabama conducted a similar study in 1996. This study investigated the effectiveness of a methods course in reducing the level of mathematics anxiety among three groups of preservice teachers majoring in elementary education. They, too, administered the MARS to their subjects at the beginning and end of the methods course. Throughout the ten-week course the subjects, sixty-one in all, participated in activities which included the use of manipulatives. Sloan, Vinson, Haynes and Gresham wrote that "the manipulatives were incorporated in a conceptual manner with techniques, strategies, and activities aimed at the K-3 curriculum" (Sloan, Vinson, Haynes, & Gresham, 1997, p. 16). The results of the study indicated that the methods course did indeed significantly reduce the subjects' level of mathematics anxiety ($p<.05$).

In addition to administering the MARS, the researchers also conducted personal interviews with their subjects. In these interviews many subjects pointed to the methodology and the welcoming atmosphere of the course as the reason for their lower level of mathematics anxiety. Sloan, Vinson, Haynes, & Gresham stated, "The most unanimous and interesting comment was that the participants felt as though their math anxieties could have in fact been prevented in elementary school, if they had received

instruction through concrete manipulatives" (Sloan, Vinson, Haynes, & Gresham, 1997, p. 22). However, thirteen subjects actually experienced an increase in their anxiety towards mathematics. When interviewed, these subjects pointed to the use of unfamiliar manipulatives, such as Cuisennaire rods, and teaching in front of their peers as the reason for their increase in mathematics anxiety (Sloan, Vinson, Haynes, & Gresham, 1997).

Even though research has indicated that anxiety toward mathematics is widespread among preservice teachers, it has shown that for many their level of anxiety can be significantly reduced through an experienced-based mathematics methods course. This is important because it is this anxiety that has been known to affect both the teaching and learning of mathematics. Therefore, a mathematics methods course should be included in the curriculum for preservice teachers in order to reduce their level of anxiety toward mathematics (Tooke & Lindstrom, 1998).

Attitudes toward Mathematics

Attitudes toward mathematics can be defined as "the level of like or dislike felt by an individual toward mathematics" (Quinn, 1997, p. 108). Research has shown that preservice teachers tend to possess a less favorable attitude toward mathematics than other college majors (Quinn, 1997). Preservice teachers' attitudes toward mathematics not only effect their learning to teach mathematics, but they can also affect their students' performance in mathematics. In his research on teacher attitudes toward mathematics, Aiken (1972) found that students' negative attitudes toward mathematics can be a result of their parents' attitudes toward mathematics, poor academic

performance in mathematics, or teachers' attitudes toward mathematics (Wagner, Lee, & Ozgun-Koca, 1999).

In 1992 Robert Quinn conducted a study to examine the effects of mathematics methods courses that use manipulatives, technology, and cooperative learning on preservice teachers' attitudes toward mathematics. Quinn used Aiken's Revised Mathematics Attitude Scale, developed by L.R. Aiken in 1963, to measure the attitudes toward mathematics possessed by 47 preservice teachers at the University of Nevada, Las Vegas. The Aiken's Revised Mathematics Attitude Scale consists of 20 items to be judged by the participant on a 5-point Likert-type scale. Quinn awarded points for each item based on the level of the response. He reversed negatively stated items so that the higher scores indicated a more positive attitude toward mathematics than the lower scores did. Scores could range from 0 to 80. Quinn administered the Aiken's Revised Mathematics Attitude Scale at the beginning and end of the semester to both elementary and secondary preservice teachers. Quinn wrote the following:

> I performed a correlated–groups t test comparing the preservice elementary teachers' scores on the pretest (M=39.5) and posttest (M=43.3) of the Aiken's Revised Mathematics Attitude Scale. The difference was statistically significant, $t(27) = 2.32$, $p<.05$, indicating that preservice elementary teachers' attitudes toward mathematics had improved significantly between the beginning and the conclusion of the elementary mathematics methods course…I performed a correlated-groups t test comparing the preservice secondary mathematics teacher's scores on the pretest (M=64.1) of Aiken's Revised

> Mathematics Attitude Scale. The difference was not statistically significant, t (18) = 1.65, p = .117. (Quinn, 1997, p. 111)

One plausible explanation for the lack of significant changes among secondary preservice teachers' attitudes was that they possessed more positive attitudes toward mathematics at the beginning of the methods course than their elementary peers did.

Ronald M. Benbow (1993) conducted a study to measure what effect, if any, that an integrated content-methods, two-course sequence had on the mathematical beliefs held by preservice elementary teachers. His study took place at Taylor University in north-central Indiana. There were twenty-seven participants. Three of the participants were freshman, ten were sophomores, and fourteen were juniors. Benbow states that the academic profile of these students placed them above the national average. The participants were given the Indiana Mathematics Beliefs Scales (IMBS) before and after the two-course sequence. The first course, Math 201, included topics such as the number system through real numbers, statistics, and probability. The second course, Math 202, focused on topics such as geometry, measurement, and problem solving. The courses also included the use of concrete teaching aids, computers, and calculators. Benbow writes:

> Through the integrated structure of the courses, the goal is to provide students with opportunities to increase the depth of their knowledge of topics appropriate for the elementary and middle schools and simultaneously examine sound pedagogical practices for teaching those topics to children. The underlying rationale for such a program structure is its more natural ability to integrate

> students' content and pedagogical content knowledge rather than trying to artificially separate them. (p. 5)

The results indicated some changes in the preservice teachers' beliefs or attitudes toward mathematics. They now saw mathematics as being less rule-oriented and less dependent upon memorization. Also, they no longer viewed mathematics as being "totally right-wrong, one answer-one method terms" (Benbow, p. 5).

Research shows that preservice teachers' negative attitudes toward mathematics can change as a result of a nontraditional mathematics methods course. This impact is critical because teachers' attitudes can have an incredible effect on their teaching performance as well as their students' attitudes and academic performance.

Content Knowledge

Many mathematics methods educators claim that most teachers do not have the necessary mathematical content knowledge and mathematical pedagogical knowledge required to effectively teach mathematics. Many also claim that content knowledge itself determines a teacher's effectiveness. In addition to these claims, research studies show that preservice elementary teachers lack the deep understanding of mathematics that is required for teaching it at a conceptual level (Hadfield, Littleton, Steiner, & Woods, 1998). Not everyone, however, agrees on a solution to this problem. Some point to a need for more mathematics content courses, while others claim that methods courses can bridge the gap.

In addition to studying the effects that mathematical methods courses have on preservice teachers' attitudes toward mathematics, Robert Quinn also studied how these courses effect preservice teachers' content of mathematical knowledge. Quinn used a

revised version of the Essential Elements of Elementary School Mathematics Test, developed by M.A. White, to measure each participant's meaningful knowledge of mathematical content, which he defined as "a conceptual and intuitive understanding of mathematics" (Quinn, 1997, p. 108). Quinn's test included 25 multiple choice questions that dealt with numerous topics such as fractions, percentages, area, perimeter, measurement, probability, and statistics. All of the questions were on a sixth grade level. He administered the test to all 47 preservice teachers at the beginning and end of the semester. Quinn performed a correlated-groups t test comparing the preservice elementary teachers' scores on both the pretest (M=15.2) and the posttest (M=16.9). He found the difference to be statistically significant among preservice elementary teachers, $t(26) = 4.6$, $p<.001$. Therefore, he concluded that the mathematical content of preservice elementary teachers had been increased as a result of their methods course. However, when he performed the same test on preservice secondary teachers, the results were not statistically significant. Quinn wrote the following:

> The inadequacies in the meaningful knowledge of mathematical content of preservice elementary teachers must be addressed. Changes should be made in their content courses, their methods courses, or both, to include increased emphasis on long division, geometry, probability, and statistics. In particular, these mathematical topics should be presented in a manner that helps preservice teachers develop meaningful knowledge. (p. 112)

A more recent study contradicts this viewpoint. Hadfield, Littleton, Steiner, and Woods (1998) performed a study to examine the effects of preservice teachers' content knowledge, spatial skills, and anxiety toward mathematics on their ability to teach

mathematics. Their study included 48 preservice elementary teachers enrolled in a mathematics methods course. The methods class met twice a week for an hour and a half over a sixteen-week period. Each class consisted of a combination of lecture, discussion, and lab activities. The use of manipulatives and hands-on activities was emphasized throughout the course. The researchers state "all of the students alternated between the roles of teacher and student during each laboratory activity, with the primary goal being to teach the material 'conceptually' " (Hadfield, Littleton, Steiner, & Woods, 1998, p. 39). All 48 preservice teachers were videotaped teaching three self-designed micro-lessons. In addition to taping the micro-lessons, each participant completed quizzes which measured pedagogical content knowledge. Each participant also completed a general mathematics content knowledge test. "The content began with elementary school level procedures and story problems, and continued through beginning algebra and trigonometry" (Hadfield, Littleton, Steiner, & Woods, 1998, p. 38). Even though the instrument was not normed or tested for its validity or reliability, the researchers state that it was very similar to high school and secondary placement tests. The participants were also given the MARS test to measure their anxiety toward mathematics and the Space Relations Subtest of the Differential Aptitudes Test (DAT) to measure their spatial skills. The authors write:

> The results of this study indicate that general mathematics content knowledge, the affective aspects of mathematics learning (mathematics anxiety), and spatial skills do not impact preservice pedagogical effectiveness (as measured by video taped performance assigned in this methodology course) as compared to quiz grades designed as measures of acquisition of specific teaching skills for

> mathematics (pedagogical content knowledge). This implies that mathematics methodology courses for preservice elementary teachers can be successful for most students, regardless of their prior levels of general mathematics knowledge, spatial ability, or fears concerning mathematics. (p. 43)

These researchers assert that emphasis on pedagogical content knowledge, rather than subject matter content knowledge, is the answer for developing effective mathematics teachers.

Pedagogical Beliefs

In the past, mathematics teachers have stressed procedures. This type of teaching has resulted in students becoming passive learners. Today educators involved in the current mathematics reform movement stress a constructivist approach to learning, where students are encouraged to actively build their own knowledge. Unfortunately, this method of teaching requires many teachers to change their beliefs about mathematics, mathematics teaching, and mathematics learning (Steele, 1994).

Marta Civil (1992) analyzed the pedagogical beliefs held by eight preservice elementary teachers enrolled in a mathematics methods course for elementary majors. The summer course met for two hours every day, five days a week, for eight weeks. All of the participants were female. Civil, the instructor for the course, stated that she did very little lecturing. Instead, she emphasized small group discussions and a constructivist approach to learning mathematics. Civil writes, "I challenged the students' beliefs and pushed them to consider their ideas-something many of them had probably never done. The students were encouraged to advance their own ideas and construct their understanding of mathematics" (Civil, 1992, p. 2). With regards to

teaching mathematics, Civil writes that the most predominant idea held by all of the participants was that the role of the teacher was to give the information to the students. This traditional view of the teacher's role stemmed from their own traditional school experiences. Civil states that as a result of the mathematics methods course these preservice teachers became more reflective learners of mathematics. However, they still struggled in "trying to make sense of this course in view of their existing conceptions about teaching and learning mathematics" (Civil, 1992, p. 20).

Eunsook Hong (1995) performed a study in order to ascertain preservice elementary teachers' beliefs about teaching word problem solving. He also wanted to know what factors influenced these beliefs. Twenty-one preservice teachers participated in his study and they were interviewed before and after the course. The interviews were conducted in order to determine the influence of the methods course on the participant's instructional planning. Hong concludes:

> By the end of the methods course, fewer preservice teachers mentioned incorporating their own personal experiences in instructional planning. Preservice teachers who wanted to teach in a certain way in the pre-methods session because that is the way they had learned before or because that is the way that they had solved problems and it had worked, did not express the same reasons in the post-methods session. In addition, two preservice teachers specifically mentioned the new learning they received from the methods class as a reason they were changing the instructional strategies in the post-methods session. (p. 22)

Not all preservice teachers changed their beliefs about teaching mathematics as a result of Hong's methods course. One participant maintained that she would teach mathematics the same way that she learned it.

Cynthia Langrall, Carol Thornton, Graham Jones, and John Malone (1996) conducted a study to determine what affect, if any, that improved pedagogical knowledge and multiple interactions with the practices documented by the NCTM in the Principles and Standards of School Mathematics (1989, 1991) would have on preservice teachers' beliefs and actions in mathematics instructions. Their study included seventy-one undergraduates who were enrolled in an elementary mathematics methods course at Illinois State University. The class met for four hours each week and the NCTM Standards documents (1989, 1991) were used as the text. Throughout the course the instructors modeled an inquiry based approach toward mathematics teaching and learning. Cynthia Langrall, Carol Thornton, Graham Jones, and John Malone wrote:

> The prospective teachers engaged in collaborative problem solving; analyzed frameworks for describing children's thinking in key content areas (Carpenter & Fennema, n.d.; Guiterrez, Jaime, foruny, 1991; Jones et al., 1996; Mack, 1990); studied videotapes of classroom instruction and individual interviews with children; designed rich and high-quality mathematical tasks; and co-planned practicum lessons. (p. 272-273)

The Beliefs About Teaching Mathematics Inventory was administered at the beginning and end of the course in order to assess each participant's beliefs about teaching mathematics. This inventory consists of thirty-five items that are measured on a five-

point Likert scale. A multivariate analysis was used to examine the mean changes of the participants' scores. The authors state that the findings "indicated a significant overall gain toward more positive beliefs" (p275). They conclude by writing the following:

> This study demonstrates that an intervention program that consistently enhanced students' knowledge of key characteristics of the Standards (NCTM, 1989, 1991), engaged them in collaborative tasks involving the learning and teaching of mathematics, and provided opportunities for them to engage in reflective analysis can influence both their beliefs about teaching and their instructional practice. Their beliefs became more oriented toward the principles espoused in the Standards. (p. 279)

More recently, Robert Quinn (1998) conducted a study to determine how methods courses might affect preservice teachers' beliefs about using technology as a teaching tool. Quinn's study included both elementary and secondary preservice teachers at the University of Nevada, Las Vegas. There were twenty-eight elementary teachers and nineteen secondary preservice teachers who agreed to participate in Quinn's study. It goes without saying that both classes were exposed to the use of technology as a teaching tool throughout the course.

At the beginning of the course, Quinn asked each participant to write for eight minutes about his or her beliefs about using technical aids, such as computers and calculators, to teach mathematics. At the end of the semester each participant was interviewed about his or her current beliefs. Quinn found that initially more than three-fourths of the participants did not favor the use of technology as a mathematics teaching tool. One preservice teacher wrote that, "A dependency can be brought on by

excessive use of calculators. When a person constantly uses a calculator there is a tendency to become unsure of yourself. Basic math skills tend to deteriorate when not used" (Quinn, 1998, p. 376). Unfortunately, by the end of the semester Quinn found that their beliefs remained more or less unchanged. There were,however, some exceptions. For example, one participant stated, "In the beginning I thought of them (caluclators) as being crutches, but I don't think that anymore. I think they are more of a help overall and I don't think that it's so important that kids learn the actual calculations as it is they gain the understanding of what they are doing" (Quinn, 1998, p. 376).

Methods

Purpose and Participants

The purpose of this pilot study was to establish the foundations for a future investigation into the effects of experienced-based mathematics methods courses on the attitudes and behaviors of preservice elementary teachers. The participants in the study were 35 preservice teachers at a small church-related liberal arts college located in eastern Tennessee. Of the 35 participants, 18 were undergraduate students majoring in Elementary Education with Licensure, and 17 were graduate students in the Master of Arts in Teaching progam. At the undergraduate level, sixteen were female and two were male. At the graduate level, twelve were female and five were male. See Table 1. All of the 35 preservice teachers that were enrolled in the K-4 Mathematics Methods course and the 5-8 Mathematics Methods course agreed to participate in this study. These courses, which must be taken simultaneously, serve as an orientation to methods

and materials for teaching mathematics in the elementary and middle school. The courses in the pilot study took place during the fall semester of 2001.

Table 1
Participants

	Female – number	Female - percent	Male – number	Male – percent	Total – number	Total – percent
Undergraduate	16	89%	2	11%	18	51%
Graduate	12	71%	5	19%	17	49%
Total	28	80%	7	20%	35	100%

Setting

For the two courses, students received a total of 4 semester credit hours, meeting for 3 hours 20 minutes each week. Throughout the sixteen-week semester the students participated in, designed, and led activities that focused on curriculum, planning, and strategies for teaching and assessing K-8 mathematics. These activities were based upon the standards proposed by the NCTM, focusing upon the process standards of problem solving, reasoning, communication, connections, and representation. The students participated in, and created, activities which included manipulatives, hands-on materials, cooperative learning, and technology. The emphasis was on small group discussions and activities, a constructivist approach to learning and doing mathematics, and reflection on readings and activities. The required text for both courses was *Elementary and School Mathematics*, by John A. Van de Walle (2001).

A practicum experience was also included for both the undergraduate and graduate participants. Each participant was assigned to an elementary and a middle

school classroom where mathematics was being taught. The practicum experience required the following: at least fifty hours in the schools, eight hours of focused observations, a curriculum resource evaluation, a teacher interview, two videotaped lessons, and two teacher work samples. Participants were also required to maintain a journal for reflection.

Measures

At the beginning and end of the semester the students were asked to complete a student autobiography, a six-item questionnaire developed by the course instructor in order to assess each participant's attitudes and beliefs about mathematics and mathematics teaching (Figure 1). The questionnaire was administered during class. The participants were given as much time as they needed to complete the questionnaire. Sample items include "Things (I think) I will like most about teaching mathematics", "On a scale of 1 to 10 (low to high) my attitude toward mathematics is ____", and, "Where and how do you think your attitude toward mathematics was formed? Can you remember any specific events, people, or materials that turned you on to mathematics? Turned you off to mathematics?" Added to the post-assessment was the question, "How has this course (if at all) changed your attitude toward mathematics and teaching mathematics?"

Figure 1
K-4, 5-8 Mathematics Methods
Student Autobiography

Please answer the following questions.
Name _____

1. Things (I think) I will like most about teaching mathematics.
2. Things (I think) I will like least about teaching mathematics.
3. Given your choice of any grade level, which would you like to teach? Why?
4. On a scale of 1 to 10 (low to high) my attitude toward mathematics is ____.
5. Where and how do you think that your attitude toward mathematics was formed? Can you remember any specific events, people, or materials that turned you on to mathematics? Turned you off?
6. In your own words, what is mathematics?

Additional data was collected from eight graduate students who had completed the program and obtained teaching positions. The information was gathered from their student teaching experiences in the spring of 2002, from comprehensive examinations fulfilling requirements of the Masters program, and with telephone surveys of those in their first year of teaching in elementary schools during fall of 2002. In each case evidence was sought that would demonstrate application of the course emphases indicated above. The survey (Figure 2) also included questions regarding the process standards, materials available and used in class, and the types of teaching strategies or activities utilized.

Figure 2
K-4, 5-8 Mathematics Methods
Beginning Teacher Survey

Name _____
School _____
Grade levels you teach: _____

1. Which of the following topics have been covered in your class this year? Please indicate how often the topic is covered – frequently, sometimes, hardly ever or never.
   - Working with and solving problems to build new mathematical knowledge using a variety of strategies in situations within and without mathematics.
   - Learning to reason and construct mathematical arguments.
   - Connections among mathematical ideas and in contexts outside mathematics.
   - Mathematical representations to organize, record, and communicate as well as to model physical, social, and mathematical phenomenon.
2. Which of the following materials are available for your mathematics class?
   - Computers
   - Use of manipulatives and lab equipment
   - Use of textbooks and supplemental resources that provide for active involvement by the students
   - Calculators

3. Which of the following materials are used in your mathematics class?
   - Computers
   - Use of manipulatives and lab equipment
   - Use of textbooks and supplemental resources that provide for active involvement by the students
   - Calculators

4. How often do your students do the following types of activities?
   - Listening to the teacher explanations and taking notes
   - Completing worksheets or pages from the textbook
   - Talking about math problems as a whole class
   - Working together, in small groups, to solve math problems
   - Discussing or defending different approaches to solving problems
   - Writing assignments on math problems
   - Making oral presentations about math
   - Working on projects
   - Learning about mathematics through real-life problems

Results

Responses to the bibliography questions prior to the course varied more than responses following the course (Figure 3). Before the course, the top two responses to the question related to what they would like most about teaching mathematics indicated that the participants would like using different activities and manipulatives (29%), and seeing their students understand a concept (20%). Other responses included being fun, relating to everyday life, helping children master new concepts, building their own self-confidence as they teach concepts to others, and teaching specific concepts. One graduate participant wrote that what he would enjoy the most would be "trying to present a more positive math experience for my students" than he had experienced. The post assessment responses were 60% for using hands-on activities and manipulatives.

Next, the participants were asked to cite the things that they thought they would like least about teaching mathematics. Before the course, 68% responded with one of the following: teaching a specific content area (most listed geometry), mastering new concepts themselves, and making mathematics easy to understand. Teaching unreceptive students, not knowing how to help a struggling student, drilling students, and preparing students for standardized tests were also listed. After the course, two categories of responses came from 71% of the participants: not being able to reach, interest, motivate students and not being comfortable with the mathematical concepts, especially algebra. An undergraduate student stated, "In the upper grades, the hardest math that involves standards and algebra because I am not very good at math myself.....At least I am not as afraid as I was." Other responses included assessment

issues such as homework, grades and standardized tests; making it fun and interesting, especially in the upper grades; and being able to "think outside the box."

For the third question, the participants were asked to pick, given any choice of grade level, the grade that they thought they would like to teach. Prior to the course 80% of the participants chose K-4, compared to 69% afterward. Those choosing grades 5-8 increased from 20% to 31%.

Attitudes toward mathematics were rated on a scale of 1 to 10 (low to high). As indicated in Table 2, the pre-assessment mean for all participants was 6.36, with a standard deviation of 2.53. The mean for the undergraduate participants was 6.83 and the mean for the graduate participants was 5.85. The standard deviation for the undergraduate and graduate participants was 2.43 and 2.6, respectively. Mean scores on the post-assessment were 7.56 (SD = 1.62), 8.02 (SD = 1.31), and 7.15 (SD = 1.82) for all participants, undergraduate students and graduate students, respectively.

Table 2
Means and Standard Deviations for Attitude Scores

	Means		Standard Deviation	
	Pre-Assessment	Post-Assessment	Pre-Assessment	Post-Assessment
All participants	6.36	7.56	2.53	1.62
Undergraduates	6.83	8.02	2.43	1.31
Graduates	5.85	7.15	2.6	1.82

Analysis of variance (ANOVA) revealed that there were significant differences, $p < 0.5$ (Table 3). T-tests revealed that the differences in pre- and post-course undergraduate

scores, pre- and post-course graduate scores, pre-scores for undergraduates and graduates, and post-scores for undergraduates and graduates were not statistically significant.

Table 3
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	42.21704	14.0723	3.1917
Error	66	291.00082	4.4091	Prob > F
C Total	69	333.21786		0.0292

Although the differences were not statistically significant between any of the pertinent groups, practical significances did exist. By calculating the effect size as defined by Gall, Gall, and Borg (1999, p. 167), and establishing .33 or larger as indicating practical significance (p. 72), it was determined that differences in all groups did result in practical significances (Table 4). The largest difference was in the undergraduate scores before and after the course, with the differences in graduate student scores second in size. Taken in conjunction with the qualitative date gathered from the other sources, it can be determined that the observed results are sufficient to have implications for practice.

Table 4
Effect size Between Groups

All participants pre and post	0.578313
Graduates pre and post	0.588235
Undergraduate pre and post	0.636364
Graduates and undergraduates pre	0.389662
Graduates and undergraduates post	0.555911

To determine the factors relating to attitude, the participants were asked, "Where and how do you think that your attitudes toward mathematics was formed? Can you remember any specific events, people, or materials that turned you on to mathematics? Turned you off to mathematics?" Fifty four percent of the participants (twelve undergraduates and seven graduates) attributed their attitudes toward mathematics to experiences with teachers. Three undergraduates and four graduates (20%) stated that their attitudes toward mathematics were a result of their own personal abilities in mathematics. An additional 14%, two undergraduates and three graduates, claimed that their attitudes toward mathematics were a result of their parents' influence upon them. Others claimed that their attitude toward mathematics was developed throughout their school career, by specific topics, and through the use of manipulatives. In response to this question after the course, two participants responded that their attitudes toward mathematics had changed as a result of the methods courses. One participant wrote, "Before this class and my practicum experiences, I had a very negative outlook on math. Frankly, I hated it. Now I realize that math can be fun!"

Finally, the participants were asked to define mathematics. The pre-assessment questionnaire showed that 24 participants (11 undergraduates and 13 graduates), 69%, defined mathematics as being the study of numbers and how they relate to one another. Seventeen percent (five undergraduates and one graduate) defined mathematics as the study of everyday life skills, such as balancing a checkbook. One participant, an undergraduate, stated that, "Math is a conglomeration of problems, solutions, and life applications." Others definitions of mathematics included problem solving and pattern recognition. The post-assessment indicated only two participants restated the definition as the study of numbers and how they relate to one another. Two definitions received 34% of the responses: the study of patterns, and problem solving and discovery. The next most frequent response (23%) was learning concepts related to everyday life. The change in perception can be seen in the response of one participant, "Math is problem solving! I used to think that it was just numbers. But now I see that it includes so much more!"

A seventh question, which referred specifically to the effectiveness of the mathematics methods course, was added to the post-assessment questionnaire. It asked, "How has this course (if at all) changed your attitude toward mathematics and teaching mathematics?" Seventeen undergraduates and fifteen graduates (91%) wrote that their attitudes toward mathematics and teaching mathematics had changed as a result of the methods course. They wrote that they now had a more positive attitude toward mathematics and teaching mathematics and felt less nervous about teaching mathematics. For example, one graduate wrote, "It has changed my attitude. I feel more confident in my mathematical abilities and so I am a lot more comfortable and even

excited about teaching math." An undergraduate responded, " I have a much better attitude because I have developed several ideas on how to make math fun and interesting." Two participants, an undergraduate and a graduate, stated that they now realized that teaching mathematics was going to be more complicated than they had previously thought and that they still lacked the needed confidence. One participant, a graduate, wrote that her attitude had not really been changed by the methods course.

Demonstration of the focus criteria used in mathematics lessons and the NCTM process standards emphasized during the course were sought from activities following the course: from student teaching observations and evaluations, from responses to comprehensive examinations and from surveys given to beginning teachers. This data was collected from eight graduate students who had already completed their programs and obtained licenses. Documentation from student teaching packets revealed that positive comments relating to mathematics were found regarding six of the participants. Evidence was found that four had used manipulatives, hands-on materials, cooperative learning, and calculators. They used a variety of teaching strategies that made connections to the real-world and provided multiple representations for the mathematical situations being addressed. Responses to comprehensive examination questions from three participants referred to the process standards put forth by NCTM as important to mathematics teaching. One participant stated that it was important to create a "community where students can learn through doing, not lecture."

The follow-up survey from six of the eight participants as they progressed through their first year of teaching also indicated a continuance of the behaviors and attitudes focused upon in the course. More than two-thirds responded that they

frequently used problem solving strategies and situations, and made connections among mathematical ideas and in contexts outside mathematics. Five helped their students reason and construct mathematical arguments frequently or sometimes. All six respondents frequently or sometimes taught students to use mathematical representations to organize, record, communicate or model data or problems. Eighty-three percent use manipulatives and resources that provided for active involvement by their students. Calculators were sometimes used by 50%, but computers were rarely used. Four or more of the beginning teachers talked about problems with the whole class, used cooperative learning groups, encouraged students to defend approaches and answers, and used real-life problems. They did not use written assignments, oral presentations, or projects with students frequently.

Discussion

The data reported from this pilot study demonstrate that experienced-based methods courses can have an impact on the attitude and behavior of preservice teachers. Activities conducted in class as well as the lessons created and implemented by the preservice teachers allowed these participants to experience a constructivist approach to teaching and learning mathematics. In addition to the change of responses recorded in the pre- and post-course questionnaire, retention of improved attitudes and behaviors can be seen as much as a year later as participants conducted their own classrooms.

Initial questionnaires indicate that preservice teachers enter methods courses with a moderate level of anxiety or poor attitudes toward mathematics, as indicated in the literature. Future studies could delineate more clearly between anxiety and attitude by using the MARS or Aiken's Revised Mathematics Attitude Scale. In addition, the

link between anxiety and poor academic performance in mathematics would be of interest.

Comparison of the questionnaires before and after the course confirms that attitudes for undergraduate students as well as graduate students, traditional and non-traditional students, can be impacted by an experienced-based methods course. The ages of the participants ranged from 21 to over 40. Future studies should include more demographic information about the participants.

The participants looked forward to presenting mathematics concepts and skills with activities and hands-on materials after experiencing that type of mathematics themselves. They were, however, made more aware of the difficulties of engaging their students in these types of activities, and the risk needed to create a community of learners.

Although responses to the question of what they would dislike included topics such as algebra, many of the participants were more willing to teach the upper grades. The field experience probably had as much to do with this change as the course. Future studies could explore this aspect of change.

The self-reported attitude scores also support the conclusion that these preservice teachers felt better about teaching mathematics, even if they were not sure of their own conceptual knowledge. Taking the risk and being confident in their ability to acquire the knowledge were welcome changes.

Another indication of a change in attitude toward mathematics can be seen by the definitions of mathematics before and after the course. The change from the study of numbers to the study of patterns, problem solving, and relationships to real life

demonstrates a different perception of mathematics. As one student said, "Mathematics can be as fun as the teacher makes it." Participants' positive comments regarding the impact of the course are reflected throughout responses to other questions. Words, however, are not enough to ensure the impact of the course; evidence of behaviors that reflect these words is critical.

Although the number of participants followed through student teaching, graduation, and the beginning year of teaching was small, retention of attitudes and behaviors could be seen. It is important that the beliefs strengthened in a mathematics methods class carry forward to actually teaching experience, not only saying the right words, but demonstrating those beliefs and attitudes through behaviors. It has been said that teachers teach as they were taught. Experiences in a methods course such as that described in this paper, and in many studies of courses seen in the literature, are imperative to provide the models to be emulated by new mathematics teachers.

In response to the call for reform in mathematics education mathematics methods courses are providing the opportunity for many preservice teachers to experience a constructivist approach to the teaching and learning of mathematics. Preservice teachers enter these courses with preconceived attitudes, anxieties, and beliefs toward mathematics and mathematics teaching. These preformed dispositions are a direct result of their own traditional school experiences, and they tend to remain resistant to change. Fortunately, research studies have shown that change is possible. Preservice teachers' level of anxiety can be significantly reduced as a result of an experienced based mathematics methods course. Preservice teachers' negative attitudes can also change as a result of a nontraditional mathematics methods course. This is

important because a teacher's attitude can have an incredible affect on their teaching performance and their students' attitudes and academic performance. Also, preservice teachers' pedagogical beliefs can change from a traditional to a more constructivist approach as a result of a mathematics methods course geared toward the NCTM Standards. Finally, researchers do not agree on the impact that mathematics content knowledge possessed by preservice teachers has upon their performance as a teacher. Some call for more content oriented classes due to a lack of sufficient content knowledge, while others claim that mathematics methods courses are the key for producing effective mathematics teachers.

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